

# McCORMICK TURBINES



FROM  
BOSTON OFFICE  
S. Morgan Smith Co.  
176 FEDERAL ST.

S. MORGAN SMITH CO.  
YORK, PA.

Bulletin 110

# McCORMICK TURBINES

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MANUFACTURED BY  
**S. MORGAN SMITH CO.**  
YORK, PA., U. S. A.

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## BRANCH OFFICES

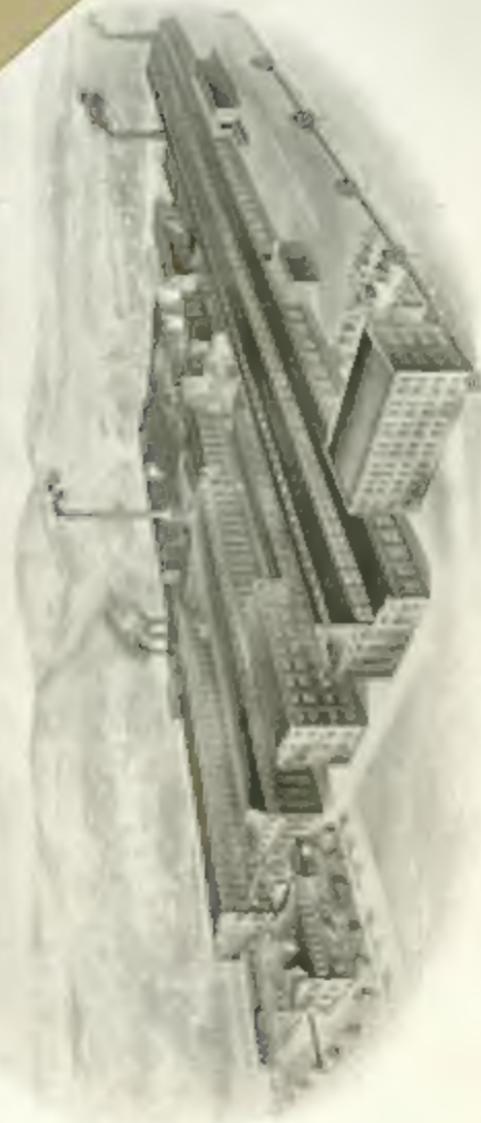
**BOSTON**  
176 Federal St.

**CHICAGO**  
76 West Monroe St.

**MONTRÉAL**  
405 Power Bldg.

*Cable Address*  
"Success"

*Codes:* ABC 4th and 5th Edition  
Lieber's  
Western Union  
Bentley's



THE WORLD'S LARGEST HYDRAULIC TURBINE WORKS

S. MORGAN SMITH COMPANY, YORK, PA.

## Introductory.

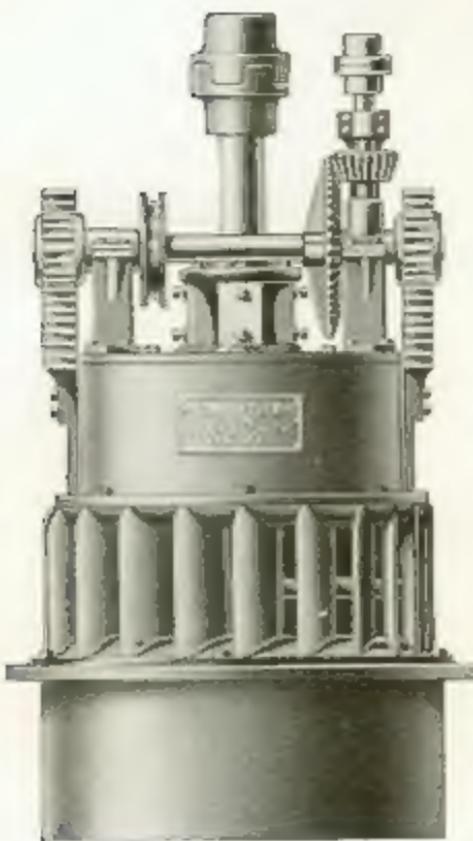
OUR purpose in publishing this Bulletin is to be able to present to our many customers, who are using the well known McCormick cylinder gate turbine, a set of tables giving the power, speed and water consumption of same, and also to meet the requirements where we quote on small turbines of this type to prospective customers who prefer a cylinder gate wheel.

This Bulletin does not represent the complete line of turbines built by this Company, as we continue to build the New Success turbine and also the Smith turbine. We have, also, designed and built many other types of turbines, some of which develop much greater capacity and higher speed than either the McCormick, New Success or Smith turbines.

Those contemplating the purchase of turbine water wheels and accessories will find it to their interest to communicate with this Company as our designing and estimating departments are at all times at the service of our prospective customers.

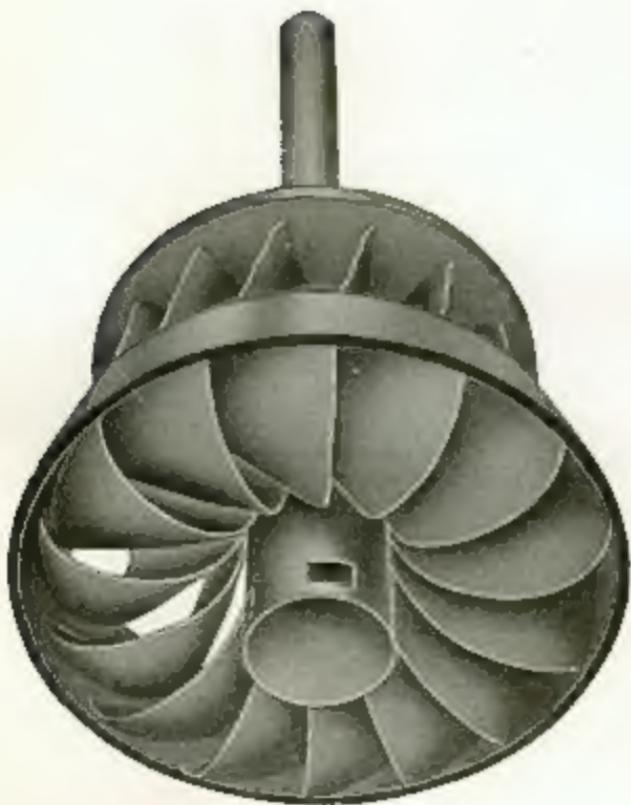
S. MORGAN SMITH COMPANY,  
YORK, PA.

## “The McCormick”



Engraving No. 401.

Represents the standard vertical McCormick Turbine. All wheels 24" and smaller will be shipped complete as shown. Larger sizes will be shipped in sections for convenience in handling.



Engraving No. 402.

Represents the standard McCormick runner with its shaft and cast iron step shoe. These standard runners are made of cast iron. Attention is called to the openings for water for cooling the concave surface of the step shoe that turns on the lignum vitae step.

## Directions for the Construction of Head and Tail Races

### THE HEAD RACE

In constructing the canal or head race, a very frequent error is committed by failing to give it sufficient capacity. It should be wide and deep, and especially where the race is of considerable length, and a large quantity of water is to pass through it. As a general rule, the water should not flow faster than from 60 to 120 feet per minute. Where there is a long race, after the turbine has been running three or four hours the head frequently draws down from one to three feet. The effect of this is the same as if the dam had been lowered an equal distance—resulting in a loss of power, which would have been prevented by making the race as wide and deep as it should be.

When the water is to be conveyed through pipes to the turbines operating under low heads, the receiving ends of the pipes should be well submerged so as prevent any possibility of their drawing air. The diameter of the pipe to be recommended varies according to the quantity of water, length and contour of the pipe, head of water acting on the turbine and the head loss permissible due to friction.

### THE TAIL RACE

This should be wide and deep, and the level of the bottom of the wheel pit should be carried from ten to forty feet below the end of flume, depending upon the amount of water discharged by the turbine, and if possible it should be carried out to the bed of the stream, as no tail race for even small turbines should have less than two feet of dead water in it before the turbines are put in motion, and where large turbines (using considerable water) are to be used, the tail race should have three or four feet of dead water in its entire length. By having the tail race thus constructed, as soon as the water is discharged from the turbines, it will push out or displace the dead water in the race, thus preventing a loss of head. For instance, to be more explicit, suppose the bottom of tail race is on a level with the water in main stream into which the tail

race discharges, when the turbines are started the water in tail race would rise in proportion to the width of the race and the quantity of water flowing therein, and reduce the working head in proportion; while if the race were as first above stated, the water from the turbines would displace the dead water without rising above the water in the main stream, thus utilizing the full amount of head. From one to three feet of working head is often lost for want of proper depth and width of tail race.

#### WHEEL PIT

Here is where mill owners and millwrights, in putting in turbines are more liable to err than elsewhere. Whether under high or low heads, the pit should be deep and wide. There is no case where this is more important than where a large turbine is run under a low head; as under these circumstances it is not desirable to lose any head whatever. A pit of insufficient size causes the water to react upon the turbine, and an additional loss of power is also caused by the fact that a portion of the head is consumed in forcing the water out of the pit when there is not sufficient outlet. As a rule, the depth of the pit should not be less than the diameter of the lower end of the draft tube.

Water has but 100 per cent. in it, and a turbine that takes out from 80 to 90 of that per cent. leaves but little force in it. To expect that the water coming through our turbines will have power to wash the sand and gravel out of their own pit, is to expect what will not be realized. Hence in putting in turbines, do not calculate upon the water in the wheel pit to do any work. If you find it foaming and dashing in the pit, then rest assured that the pit is either too shallow or too narrow, or both.

#### SETTING TURBINES ABOVE TAIL WATER

Sometimes in adapting turbines to high and even low heads, it becomes necessary to set the turbines some distance above the tail water and conduct the water from them through draft tubes. Better results may be obtained when turbines are set in this manner than if placed close to the tail water, provided the draft tubes are air tight and their discharge ends properly submerged. In all cases when draft tubes are used, they should be made of steel or concrete.

## Directions for Setting Wheels

In setting turbines of our manufacture in a wooden penstock, the first thing to do is to see that the floor of the flume is level. Generally a ring made of soft wood is placed on the floor around the hole, on which the draft tube flange of the wheel, which is faced off, is set. It is very important that the flume be built on good foundations so as not to settle when the water is let in; a very good plan, and especially where large turbines are to be set, is to put four posts or iron columns under the timbers around the hole in the floor through which the draft tube passes.

The step and all bearings of the turbines are carefully adjusted before leaving the shops.

When turbines are shipped "knocked down," the draft tube should always be set in position first, then the runner or wheel proper placed on the step, then set the case and so on until all parts are together. When the step is properly adjusted, there will be a space between the top of the band of the runner and the bottom or inner edge of the bottom plate of  $\frac{3}{16}$ ". When the turbines are not to be run for some time, the step shoes should be well covered with tallow to prevent rusting.

### WARRANTY

Turbines installed in accordance with our instructions and operated at speeds recommended by us, for each installation, failing to give the power guaranteed by us, can be returned if not broken, to the station to which they were shipped any time within thirty days, and the money received for such wheels will be refunded. If purchaser finds it impossible to put the turbine in and give it a trial within the thirty days allotted, and wants more time it will be granted on application, not exceeding in all sixty days from date of shipment.

S. MORGAN SMITH COMPANY.

## Test and Tables of Turbines

The tables of the turbines of our manufacture are based on actual tests made in the Holyoke Testing Flume—the *only reliable testing flume in the country*. Both right and left hand turbines have been tested and brought to over 80 per cent. efficiency. Although our tables are only based on 80 per cent. useful effect from the water used, all of the turbines have exceeded 80 per cent. in the tests, *some sizes having given over 90 per cent. at less than full gate with very high average from half to full gate*.

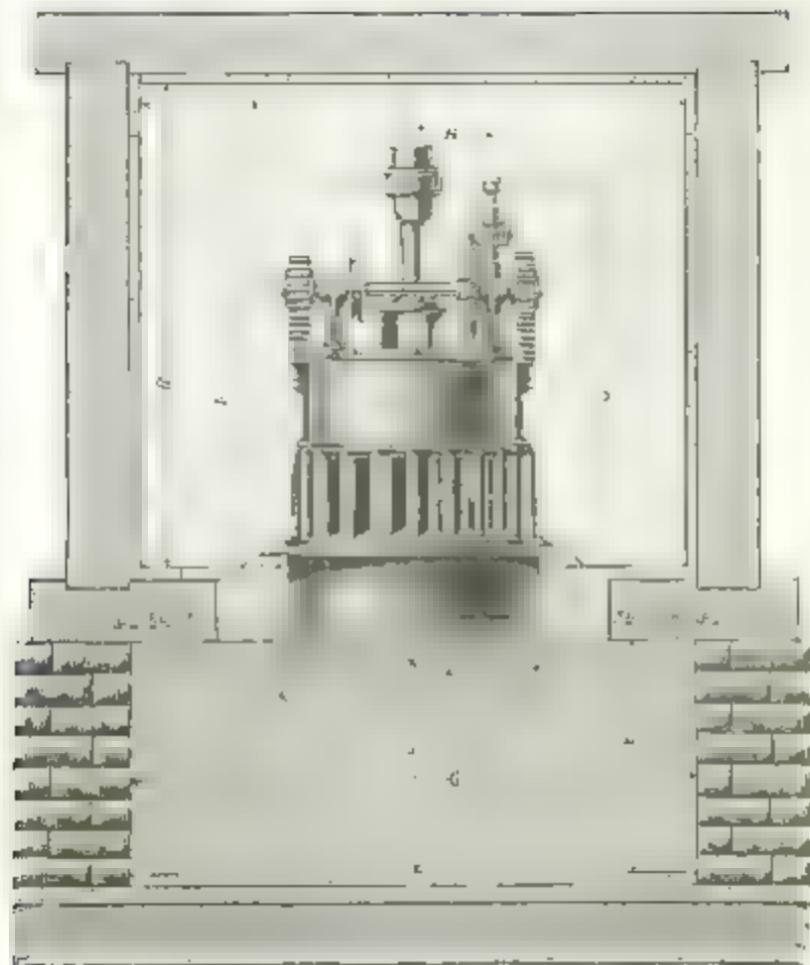
When comparing the tables of our turbines with those of other manufacturers, satisfy yourself that the tables of those turbines are reliably made. Many turbine builders have tabled their turbines at 80 or even 90 per cent., when if the truth were known, their turbines in actual test would not exceed 60 to 70 per cent.

Before purchasing a turbine be assured that the tables of the particular size turbine you require are based on actual tests made in the new flume of the Holyoke Water Power Company. Water powers are becoming more valuable each year, and the owners of water powers cannot afford to run turbines which sacrifice water and give but little power.

The following rule will enable you to determine the percentage at which any turbine is tabled.

### RULE

Multiply the cubic feet of water by 62½, which is the weight of one cubic foot of water; multiply the product by the head, which will give the foot pounds; divide that product by 33,000, which gives the full horse-power of the water; divide the horse-power claimed by the full horse-power of the water, and the result will be the percentage at which the turbine is tabled.



Engraving No. 403

# DIMENSIONS of TURBINES and PENSTOCKS IN INCHES

Lettered dimensions on page I with letters in engraving on page

Diameter inches	A		B		C		D		E		F		G		H		I		J		K	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
4	46	117	4	102	74	188	16	410	22	544	138	144	366	22	22	56	143	36	22	56		
4.2	49	125	4.2	107	76	194	19	429	23	564	143	146	376	23	23	58	148	376	23	58		
4.8	54	137	4.8	118	82	208	22	457	27	614	156	151	389	27	27	63	159	389	27	63		
5.4	59	150	5.4	132	88	222	26	484	31	644	168	156	401	31	31	67	171	401	31	67		
6.0	65	165	6.0	152	95	238	30	513	36	684	183	164	421	36	36	73	188	421	36	73		
7.2	77	196	7.2	188	107	268	37	557	44	744	198	174	454	44	44	84	213	454	44	84		
7.8	82	208	7.8	203	112	282	42	592	49	784	213	182	482	49	49	92	228	482	49	92		
8.0	85	216	8.0	213	115	288	45	604	52	794	223	185	494	52	52	95	233	494	52	95		
8.8	92	228	8.8	226	120	302	50	637	57	824	238	192	512	57	57	102	253	512	57	102		
9.0	95	235	9.0	232	122	308	52	653	59	844	253	194	524	59	59	104	263	524	59	104		
10.0	110	279	10.0	254	134	322	58	707	66	904	273	214	574	66	66	114	283	574	66	114		
10.2	112	283	10.2	257	136	326	60	723	68	924	283	216	594	68	68	116	293	594	68	116		
10.8	118	295	10.8	268	142	338	66	757	74	954	298	222	624	74	74	122	308	624	74	122		
11.0	120	303	11.0	274	144	342	68	773	76	974	308	224	644	76	76	124	318	644	76	124		
11.2	124	307	11.2	278	148	348	72	800	80	1004	318	230	674	80	80	128	328	674	80	128		
11.8	134	324	11.8	294	154	358	78	837	86	1034	328	236	704	86	86	136	338	704	86	136		
12.0	136	330	12.0	296	156	362	80	853	88	1054	338	238	724	88	88	138	348	724	88	138		
12.2	138	333	12.2	298	158	366	82	873	90	1074	348	240	744	90	90	140	358	744	90	140		
12.8	144	344	12.8	308	164	378	88	907	96	1104	358	246	774	96	96	146	368	774	96	146		
13.0	146	348	13.0	312	166	382	90	923	98	1124	368	248	794	98	98	148	378	794	98	148		
13.2	148	352	13.2	316	168	386	92	943	100	1144	378	250	814	100	100	150	388	814	100	150		
13.8	154	364	13.8	326	174	398	98	987	106	1184	388	256	854	106	106	156	398	854	106	156		
14.0	156	368	14.0	330	176	402	100	1003	108	1204	398	258	874	108	108	158	408	874	108	158		
14.2	158	372	14.2	334	178	406	102	1023	110	1224	408	260	894	110	110	160	418	894	110	160		
14.8	164	384	14.8	344	184	418	108	1067	116	1264	418	266	934	116	116	166	428	934	116	166		
15.0	166	388	15.0	348	186	422	110	1083	118	1284	428	268	954	118	118	168	438	954	118	168		
15.2	168	392	15.2	352	188	426	112	1103	120	1304	438	270	974	120	120	170	448	974	120	170		
15.8	174	404	15.8	364	194	438	118	1147	126	1344	448	276	1034	126	126	176	458	1034	126	176		
16.0	176	408	16.0	368	196	442	120	1163	128	1364	458	278	1054	128	128	178	468	1054	128	178		
16.2	178	412	16.2	372	198	446	122	1183	130	1384	468	280	1074	130	130	180	478	1074	130	180		
16.8	184	424	16.8	384	204	458	128	1227	136	1424	478	286	1134	136	136	186	488	1134	136	186		
17.0	186	428	17.0	388	206	462	130	1243	138	1444	488	288	1154	138	138	188	498	1154	138	188		
17.2	188	432	17.2	392	208	466	132	1263	140	1464	498	290	1174	140	140	190	508	1174	140	190		
17.8	194	444	17.8	404	214	478	138	1307	146	1524	508	296	1234	146	146	196	518	1234	146	196		
18.0	196	448	18.0	408	216	482	140	1323	148	1544	518	300	1254	148	148	198	528	1254	148	198		
18.2	198	452	18.2	412	218	486	142	1343	150	1564	528	302	1274	150	150	200	538	1274	150	200		
18.8	204	464	18.8	424	224	498	148	1387	156	1624	538	308	1334	156	156	206	548	1334	156	206		
19.0	206	468	19.0	428	226	502	150	1403	158	1644	548	310	1354	158	158	208	558	1354	158	208		
19.2	208	472	19.2	432	228	506	152	1423	160	1664	558	312	1374	160	160	210	568	1374	160	210		
19.8	214	484	19.8	444	234	518	158	1467	166	1724	568	318	1434	166	166	216	578	1434	166	216		
20.0	216	488	20.0	448	236	522	160	1483	168	1744	578	320	1454	168	168	218	588	1454	168	218		
20.2	218	492	20.2	452	238	526	162	1503	170	1764	588	322	1474	170	170	220	598	1474	170	220		
20.8	224	504	20.8	464	244	538	168	1547	176	1824	598	328	1534	176	176	226	608	1534	176	226		
21.0	226	508	21.0	468	246	542	170	1563	178	1844	608	330	1554	178	178	228	618	1554	178	228		
21.2	228	512	21.2	472	248	546	172	1583	180	1864	618	332	1574	180	180	230	628	1574	180	230		
21.8	234	524	21.8	484	254	558	178	1627	186	1924	628	338	1634	186	186	236	638	1634	186	236		
22.0	236	528	22.0	488	256	562	180	1643	188	1944	638	340	1654	188	188	238	648	1654	188	238		
22.2	238	532	22.2	492	258	566	182	1663	190	1964	648	342	1674	190	190	240	658	1674	190	240		
22.8	244	544	22.8	504	264	578	188	1707	196	2024	658	348	1734	196	196	246	668	1734	196	246		
23.0	246	548	23.0	508	266	582	190	1723	198	2044	668	350	1754	198	198	248	678	1754	198	248		
23.2	248	552	23.2	512	268	586	192	1743	200	2064	678	352	1774	200	200	250	688	1774	200	250		
23.8	254	564	23.8	524	274	598	198	1787	206	2124	688	358	1834	206	206	256	698	1834	206	256		
24.0	256	568	24.0	528	276	602	200	1803	208	2144	698	360	1854	208	208	258	708	1854	208	258		
24.2	258	572	24.2	532	278	606	202	1823	210	2164	708	362	1874	210	210	260	718	1874	210	260		
24.8	264	584	24.8	544	284	618	208	1867	216	2224	718	368	1934	216	216	266	728	1934	216	266		
25.0	266	588	25.0	548	286	622	210	1883	218	2244	728	370	1954	218	218	268	738	1954	218	268		
25.2	268	592	25.2	552	288	626	212	1903	220	2264	738	372	1974	220	220	270	748	1974	220	270		
25.8	274	604	25.8	564	294	638	218	1947	226	2324	748	378	2034	226	226	276	758	2034	226	276		
26.0	276	608	26.0	568	296	642	220	1963	228	2344	758	380	2054	228	228	278	768	2054	228	278		
26.2	278	612	26.2	572	298	646	222	1983	230	2364	768	382	2074	230	230	280	778	2074	230	280		
26.8	284	624	26.8	584	304	658	228	2027	236	2424	778	388	2134	236	236	286	788	2134	236	286		
27.0	286	628	27.0	588	306	662	230	2043	238	2444	788	390	2154	238	238	288	798	2154	238	288		
27.2	288	632	27.2	592	308	666	232	2063	240	2464	798	392	2174	240	240	290	808	2174	240	290		
27.8	294	644	27.8	604	314	678	238	2107	246	2524	808	398	2234	246	246	296	808	2234	246	296		
28.0	296	648	28.0	608	316	682	240	2123	248	2544	808	400	2254	248	248	298	808	2254	248	298		
28.2	298	652	28.2	612	3																	

## 9-INCH WHEEL

Brad.	Revolutions per Minute	Discharge, Cubic feet per second	Horse Power
2 1/2	204	1	1
3 1/2	227	1.5	1.5
4	241	2	2
4 1/2	250	2.5	2.5
5	253	3	3
5 1/2	255	3.5	3.5
6	256	4	4
6 1/2	257	4.5	4.5
7	258	5	5
7 1/2	259	5.5	5.5
8	260	6	6
8 1/2	260	6.5	6.5
9	260	7	7
9 1/2	260	7.5	7.5
10	260	8	8
10 1/2	260	8.5	8.5
11	260	9	9
11 1/2	260	9.5	9.5
12	260	10	10
12 1/2	260	10.5	10.5
13	260	11	11
13 1/2	260	11.5	11.5
14	260	12	12
14 1/2	260	12.5	12.5
15	260	13	13
15 1/2	260	13.5	13.5
16	260	14	14
16 1/2	260	14.5	14.5
17	260	15	15
17 1/2	260	15.5	15.5
18	260	16	16
18 1/2	260	16.5	16.5
19	260	17	17
19 1/2	260	17.5	17.5
20	260	18	18
20 1/2	260	18.5	18.5
21	260	19	19
21 1/2	260	19.5	19.5
22	260	20	20
22 1/2	260	20.5	20.5
23	260	21	21
23 1/2	260	21.5	21.5
24	260	22	22
24 1/2	260	22.5	22.5
25	260	23	23
25 1/2	260	23.5	23.5
26	260	24	24
26 1/2	260	24.5	24.5
27	260	25	25
27 1/2	260	25.5	25.5
28	260	26	26
28 1/2	260	26.5	26.5
29	260	27	27
29 1/2	260	27.5	27.5
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30 1/2	260	28.5	28.5
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31 1/2	260	29.5	29.5
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39	260	37	37
39 1/2	260	37.5	37.5
40	260	38	38
40 1/2	260	38.5	38.5
41	260	39	39
41 1/2	260	39.5	39.5
42	260	40	40
42 1/2	260	40.5	40.5
43	260	41	41
43 1/2	260	41.5	41.5
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44 1/2	260	42.5	42.5
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45 1/2	260	43.5	43.5
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47	260	45	45
47 1/2	260	45.5	45.5
48	260	46	46
48 1/2	260	46.5	46.5
49	260	47	47
49 1/2	260	47.5	47.5
50	260	48	48
50 1/2	260	48.5	48.5
51	260	49	49
51 1/2	260	49.5	49.5
52	260	50	50
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66	260	64	64
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67	260	65	65
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71	260	69	69
71 1/2	260	69.5	69.5
72	260	70	70
72 1/2	260	70.5	70.5
73	260	71	71
73 1/2	260	71.5	71.5
74	260	72	72
74 1/2	260	72.5	72.5
75	260	73	73
75 1/2	260	73.5	73.5
76	260	74	74
76 1/2	260	74.5	74.5
77	260	75	75
77 1/2	260	75.5	75.5
78	260	76	76
78 1/2	260	76.5	76.5
79	260	77	77
79 1/2	260	77.5	77.5
80	260	78	78
80 1/2	260	78.5	78.5
81	260	79	79
81 1/2	260	79.5	79.5
82	260	80	80
82 1/2	260	80.5	80.5
83	260	81	81
83 1/2	260	81.5	81.5
84	260	82	82
84 1/2	260	82.5	82.5
85	260	83	83
85 1/2	260	83.5	83.5
86	260	84	84
86 1/2	260	84.5	84.5
87	260	85	85
87 1/2	260	85.5	85.5
88	260	86	86
88 1/2	260	86.5	86.5
89	260	87	87
89 1/2	260	87.5	87.5
90	260	88	88
90 1/2	260	88.5	88.5
91	260	89	89
91 1/2	260	89.5	89.5
92	260	90	90
92 1/2	260	90.5	90.5
93	260	91	91
93 1/2	260	91.5	91.5
94	260	92	92
94 1/2	260	92.5	92.5
95	260	93	93
95 1/2	260	93.5	93.5
96	260	94	94
96 1/2	260	94.5	94.5
97	260	95	95
97 1/2	260	95.5	95.5
98	260	96	96
98 1/2	260	96.5	96.5
99	260	97	97
99 1/2	260	97.5	97.5
100	260	98	98
100 1/2	260	98.5	98.5
101	260	99	99
101 1/2	260	99.5	99.5
102	260	100	100
102 1/2	260	100.5	100.5
103	260	101	101
103 1/2	260	101.5	101.5
104	260	102	102
104 1/2	260	102.5	102.5
105	260	103	103
105 1/2	260	103.5	103.5
106	260	104	104
106 1/2	260	104.5	104.5
107	260	105	105
107 1/2	260	105.5	105.5
108	260	106	106
108 1/2	260	106.5	106.5
109	260	107	107
109 1/2	260	107.5	107.5
110	260	108	108
110 1/2	260	108.5	108.5
111	260	109	109
111 1/2	260	109.5	109.5
112	260	110	110
112 1/2	260	110.5	110.5
113	260	111	111
113 1/2	260	111.5	111.5
114	260	112	112
114 1/2	260	112.5	112.5
115	260	113	113
115 1/2	260	113.5	113.5
116	260	114	114
116 1/2	260	114.5	114.5
117	260	115	115
117 1/2	260	115.5	115.5
118	260	116	116
118 1/2	260	116.5	116.5
119	260	117	117
119 1/2	260	117.5	117.5
120	260	118	118
120 1/2	260	118.5	118.5
121	260	119	119
121 1/2	260	119.5	119.5
122	260	120	120
122 1/2	260	120.5	120.5
123	260	121	121
123 1/2	260	121.5	121.5
124	260	122	122
124 1/2	260	122.5	122.5
125	260	123	123
125 1/2	260	123.5	123.5
126	260	124	124
126 1/2	260	124.5	124.5
127	260	125	125
127 1/2	260	125.5	125.5
128	260	126	126
128 1/2	260	126.5	126.5
129	260	127	127
129 1/2	260	127.5	127.5
130	260	128	128
130 1/2	260	128.5	128.5
131	260	129	129
131 1/2	260	129.5	129.5
132	260	130	130
132 1/2	260	130.5	130.5
133	260	131	131
133 1/2	260	131.5	131.5
134	260	132	132
134 1/2	260	132.5	132.5
135	260	133	133
135 1/2	260	133.5	133.5
136	260	134	134
136 1/2	260	134.5	134.5
137	260	135	135
137 1/2	260	135.5	135.5
138	260	136	136
138 1/2	260	136.5	136.5
139	260	137	137
139 1/2	260	137.5	137.5
140	260	138	138
140 1/2	260	138.5	138.5
141	260	139	139
141 1/2	260	139.5	139.5
142	260	140	140
142 1/2	260	140.5	140.5
143	260	141	141
143 1/2	260	141.5	141.5
144	260	142	142
144 1/2	260	142.5	142.5
145	260	143	143
145 1/2	260	143.5	143.5
146	260	144	144
146 1/2	260	144.5	144.5
147	260	145	145
147 1/2	260	145.5	145.5
148	260	146	146
148 1/2	260	146.5	146.5
149	260	147	147
149 1/2	260	147.5	147.5
150	260	148	148
150 1/2	260	148.5	148.5
151	260	149	149
151 1/2	260	149.5	149.5
152	260	150	150
152 1/2	260	150.5	150.5
153	260	151	151
153 1/2	260	151.5	151.5
154	260	152	152
154 1/2	260	152.5	152.5
155	260	153	153
155 1/2	260	153.5	153.5
156	260	154	154
156 1/2	260	154.5	154.5
157	260	155	155
157 1/2	260	155.5	155.5
158	260	156	156
158 1/2	260	156.5	156.5
159	260	157	157
159 1/2	260	157.5	157.5
160	260	158	158
160 1/2	260	158.5	158.5
161	260	159	

## 9-INCH WHEEL

A. No.	Size of Wheel In. Dia.	Diameter Cut-off Wheel In. Dia.	Horse Power
41	85	5 <sup>1</sup> 4	2 <sup>1</sup> 2
42	87 <sup>1</sup> 2	5 <sup>1</sup> 1	3 <sup>1</sup> 5
43	87 <sup>1</sup> 4	4 <sup>1</sup> 5	2 <sup>1</sup> 8
44	87 <sup>1</sup> 7	6 <sup>1</sup> 0	4 <sup>1</sup> 2
<hr/>			
45	90 <sup>1</sup> 1	6 <sup>1</sup> 7	4 <sup>1</sup> 6
46	90 <sup>1</sup> 2	6 <sup>1</sup> 8	4 <sup>1</sup> 8
47	90 <sup>1</sup> 0	6 <sup>1</sup> 5	4 <sup>1</sup> 4
48	90 <sup>1</sup> 4	6 <sup>1</sup> 9	4 <sup>1</sup> 8
49	90 <sup>1</sup> 5	6 <sup>1</sup> 5	3 <sup>1</sup> 2
<hr/>			
50	95 <sup>1</sup> 3	6 <sup>1</sup> 5	4 <sup>1</sup> 7
51	95 <sup>1</sup> 4	6 <sup>1</sup> 7	5 <sup>1</sup> 1
52	95 <sup>1</sup> 0	6 <sup>1</sup> 3	5 <sup>1</sup> 2
53	95 <sup>1</sup> 4	6 <sup>1</sup> 7	5 <sup>1</sup> 1
54	95 <sup>1</sup> 5	6 <sup>1</sup> 3	4 <sup>1</sup> 8
<hr/>			
55	100 <sup>1</sup> 8	7 <sup>1</sup> 0	6 <sup>1</sup> 0
56	100 <sup>1</sup> 5	7 <sup>1</sup> 0	6 <sup>1</sup> 2
57	100 <sup>1</sup> 2	7 <sup>1</sup> 0	7 <sup>1</sup> 5
58	100 <sup>1</sup> 8	7 <sup>1</sup> 3	7 <sup>1</sup> 3
59	100 <sup>1</sup> 5	7 <sup>1</sup> 5	7 <sup>1</sup> 2
<hr/>			
60	111	8 <sup>1</sup> 0	8 <sup>1</sup> 1
61	112 <sup>1</sup> 0	8 <sup>1</sup> 1	8 <sup>1</sup> 2
62	114 <sup>1</sup> 2	8 <sup>1</sup> 3	8 <sup>1</sup> 2
63	115 <sup>1</sup> 7	8 <sup>1</sup> 2	8 <sup>1</sup> 3
64	117 <sup>1</sup> 3	8 <sup>1</sup> 0	8 <sup>1</sup> 2
<hr/>			
65	125 <sup>1</sup> 6	9 <sup>1</sup> 5	12 <sup>1</sup> 7
66	126 <sup>1</sup> 5	9 <sup>1</sup> 4	12 <sup>1</sup> 3
67	126 <sup>1</sup> 0	9 <sup>1</sup> 5	12 <sup>1</sup> 2
68	126 <sup>1</sup> 4	8 <sup>1</sup> 8	12 <sup>1</sup> 2
69	126 <sup>1</sup> 7	9 <sup>1</sup> 2	12 <sup>1</sup> 2

## 12-INCH WHEEL

Height 12 in. Wheel diameter 12 in. Weight 12 lb. Capacity 12 lb. per sq. in.

Size	Width	Thickness	Weight	Capacity
12	12	1	12	12
12	10	1	10	10
12	8	1	8	8
12	6	1	6	6
12	4	1	4	4
12	3	1	3	3
12	2	1	2	2
12	1	1	1	1
12	12	2	24	24
12	10	2	20	20
12	8	2	16	16
12	6	2	12	12
12	4	2	8	8
12	3	2	6	6
12	2	2	4	4
12	1	2	2	2
12	12	3	36	36
12	10	3	30	30
12	8	3	24	24
12	6	3	18	18
12	4	3	12	12
12	3	3	9	9
12	2	3	6	6
12	1	3	3	3

## 12-INCH WHEEL

Diameter	Revolutions per Minute	Discharge	
		Water Feet per Minute	Horse Power
4'	638	1017	6 1/2
4'	643	1024	7 3/4
5'	653	1037	8
5'	660	1053	8
5'	675	1075	9 1/2
4'	675	1075	7 1/2
4'	683	1081	7 1/2
4'	693	1081	7 1/2
4'	700	1088	7 1/2
5'	700	1088	8 1/2
5'	714	1124	9 1/2
5'	725	1145	10
5'	735	1165	10
5'	745	1185	10
5'	755	1205	10
6'	771	1240	11 1/2
6'	777	1244	11 1/2
6'	780	1244	12 1/2
6'	787	1250	12 1/2
6'	793	1250	12 1/2
6'	800	1256	12 1/2
7'	824	1322	14 1/2
7'	835	1338	14 1/2
7'	840	1340	14 1/2
7'	845	1345	14 1/2
7'	850	1348	14 1/2
8'	861	1363	15 1/2
8'	870	1374	15 1/2
8'	875	1380	16 1/2
8'	877	1381	16 1/2
8'	880	1384	16 1/2

## 15-INCH WHEEL

Head	Revolutions per Minut.	D inches per min.	Speed in M. P. H.	Head Pitch
5	200	6.28	4.7	4 7
6	240	7.50	5.7	5 7
7	280	8.75	6.7	6 7
8	320	10.00	7.7	7 7
9	360	11.25	8.7	8 7
10	400	12.50	9.7	9 7
11	440	13.75	10.7	10 7
12	480	15.00	11.7	11 7
13	520	16.25	12.7	12 7
14	560	17.50	13.7	13 7
15	600	18.75	14.7	14 7
16	640	20.00	15.7	15 7
17	680	21.25	16.7	16 7
18	720	22.50	17.7	17 7
19	760	23.75	18.7	18 7
20	800	25.00	19.7	19 7
21	840	26.25	20.7	20 7
22	880	27.50	21.7	21 7
23	920	28.75	22.7	22 7
24	960	30.00	23.7	23 7
25	1000	31.25	24.7	24 7
26	1040	32.50	25.7	25 7
27	1080	33.75	26.7	26 7
28	1120	35.00	27.7	27 7
29	1160	36.25	28.7	28 7
30	1200	37.50	29.7	29 7
31	1240	38.75	30.7	30 7
32	1280	40.00	31.7	31 7
33	1320	41.25	32.7	32 7
34	1360	42.50	33.7	33 7
35	1400	43.75	34.7	34 7
36	1440	45.00	35.7	35 7
37	1480	46.25	36.7	36 7
38	1520	47.50	37.7	37 7
39	1560	48.75	38.7	38 7
40	1600	50.00	39.7	39 7
41	1640	51.25	40.7	40 7
42	1680	52.50	41.7	41 7
43	1720	53.75	42.7	42 7
44	1760	55.00	43.7	43 7
45	1800	56.25	44.7	44 7
46	1840	57.50	45.7	45 7
47	1880	58.75	46.7	46 7
48	1920	60.00	47.7	47 7
49	1960	61.25	48.7	48 7
50	2000	62.50	49.7	49 7
51	2040	63.75	50.7	50 7
52	2080	65.00	51.7	51 7
53	2120	66.25	52.7	52 7
54	2160	67.50	53.7	53 7
55	2200	68.75	54.7	54 7
56	2240	70.00	55.7	55 7
57	2280	71.25	56.7	56 7
58	2320	72.50	57.7	57 7
59	2360	73.75	58.7	58 7
60	2400	75.00	59.7	59 7
61	2440	76.25	60.7	60 7
62	2480	77.50	61.7	61 7
63	2520	78.75	62.7	62 7
64	2560	80.00	63.7	63 7
65	2600	81.25	64.7	64 7
66	2640	82.50	65.7	65 7
67	2680	83.75	66.7	66 7
68	2720	85.00	67.7	67 7
69	2760	86.25	68.7	68 7
70	2800	87.50	69.7	69 7
71	2840	88.75	70.7	70 7
72	2880	90.00	71.7	71 7
73	2920	91.25	72.7	72 7
74	2960	92.50	73.7	73 7
75	3000	93.75	74.7	74 7
76	3040	95.00	75.7	75 7
77	3080	96.25	76.7	76 7
78	3120	97.50	77.7	77 7
79	3160	98.75	78.7	78 7
80	3200	100.00	79.7	79 7
81	3240	101.25	80.7	80 7
82	3280	102.50	81.7	81 7
83	3320	103.75	82.7	82 7
84	3360	105.00	83.7	83 7
85	3400	106.25	84.7	84 7
86	3440	107.50	85.7	85 7
87	3480	108.75	86.7	86 7
88	3520	110.00	87.7	87 7
89	3560	111.25	88.7	88 7
90	3600	112.50	89.7	89 7
91	3640	113.75	90.7	90 7
92	3680	115.00	91.7	91 7
93	3720	116.25	92.7	92 7
94	3760	117.50	93.7	93 7
95	3800	118.75	94.7	94 7
96	3840	120.00	95.7	95 7
97	3880	121.25	96.7	96 7
98	3920	122.50	97.7	97 7
99	3960	123.75	98.7	98 7
100	4000	125.00	99.7	99 7

## 15-INCH WHEEL

Head.	Revolutions per Min.	Distance Cubic feet per minute.	Horse Power
41	510	1621	70.4
42	515	1631	71.1
43	522	1643	70.7
44	526	1650	71.7
45	531	1663	72.5
46	539	1679	73.1
47	545	1694	73.4
48	552	1714	73.2
49	559	1732	73.4
51	563	1766	74.3
52	574	1796	74.8
53	583	1812	74.4
55	599	1834	74.4
58	607	1850	75.0
63	67	1961	76.8
64	627	1981	76.8
65	637	1991	76.8
66	647	2001	76.8
68	657	2021	77.0
71	666	2119	78.4
72	666	2119	78.8
73	673	2145	79.0
74	681	2217	80.1
75	693	2250	80.6
80	712	2265	81.4
84	741	2355	86.4
88	756	2352	82.7
95	766	2368	84.1
100	796	2332	85.6

## 24-INCH WHEEL

Head.	Front Gear M. size	Front Gear f. size	Front Gear M. soft	Front Gear f. soft	Front Gear M. hard	Front Gear f. hard
5	1 3	1				
6	1					
7	1 2	1				
8	1	1				
9	1	1				
10	1	1				
11	1	1				
12	1	1				
13	1	1				
14	1	1				
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306	1</td					

## 27-INCH WHEEL

Revol.	Reducing per Quintal	Discharge Cubic feet per minute.	Horse Power.
6	100	1,000	1/2
7	110	1,100	1/2
8	120	1,200	1/2
9	130	1,300	1/2
10	140	1,400	1/2
11	150	1,500	1/2
12	160	1,600	1/2
13	170	1,700	1/2
14	180	1,800	1/2
15	190	1,900	1/2
16	200	2,000	1/2
17	210	2,100	1/2
18	220	2,200	1/2
19	230	2,300	1/2
20	240	2,400	1/2
21	250	2,500	1/2
22	260	2,600	1/2
23	270	2,700	1/2
24	280	2,800	1/2
25	290	2,900	1/2
26	300	3,000	1/2
27	310	3,100	1/2
28	320	3,200	1/2
29	330	3,300	1/2
30	340	3,400	1/2
31	350	3,500	1/2
32	360	3,600	1/2
33	370	3,700	1/2
34	380	3,800	1/2
35	390	3,900	1/2
36	400	4,000	1/2
37	410	4,100	1/2
38	420	4,200	1/2
39	430	4,300	1/2
40	440	4,400	1/2
41	450	4,500	1/2
42	460	4,600	1/2
43	470	4,700	1/2
44	480	4,800	1/2
45	490	4,900	1/2
46	500	5,000	1/2
47	510	5,100	1/2
48	520	5,200	1/2
49	530	5,300	1/2
50	540	5,400	1/2

### 30 INCH WHEEL

## 33-INCH WHEEL

Head	Pounds on per Minute	Bit Weight		Horse Power
		Cubic feet per Minute	Weight	
5	6	24.00	21.0	
6	89	3.63	41.7	
7	96	4	32.1	
8	102	5.1	31.2	
9	109	5.8	31.6	
10	113	6.5	6.7	
11	126	7.5	2	
12	128	7.8	4.5	
13	134	8.5	9.5	
14	135	8.8	12	
15	140	9.0	11.4	
16	143	9.63	12.1	9
17	149	10.0	13.6	8
18	154	10.2	14.3	7
19	155	10.2	16.1	7
20	162	11.2	17.1	5
21	166	11.4	18.7	5
22	170	11.6	20.1	4
23	174	12.0	20.5	3
24	179	12.5	22.2	3
25	181	13.0	22.9	
26	182	13.0	23.8	
27	187	13.2	25.7	
28	192	13.5	25.8	
29	195	13.5	26.8	
30	198	13.8	32.5	
31	202	14	34.7	
32	205	14.0	35.3	
33	208	14.0	3	
34	211	14.2	36.6	
35	214	14.7	40.4	
36	217	14.8	42.7	
37	220	15.7	44.0	
38	223	16.2	45.2	
39	226	16.6	47.4	
40	229	16.9	44.3	

## 36-INCH WHEEL

Height	Width	Depth	Capacity	Load	Height	Width
5	10	6	100	100	5	10
6	10	6	100	100	6	10
7	10	6	100	100	7	10
8	10	6	100	100	8	10
9	10	6	100	100	9	10
10	10	6	100	100	10	10
11	10	6	100	100	11	10
12	10	6	100	100	12	10
13	10	6	100	100	13	10
14	10	6	100	100	14	10
15	10	6	100	100	15	10
16	10	6	100	100	16	10
17	10	6	100	100	17	10
18	10	6	100	100	18	10
19	10	6	100	100	19	10
20	10	6	100	100	20	10
21	10	6	100	100	21	10
22	10	6	100	100	22	10
23	10	6	100	100	23	10
24	10	6	100	100	24	10
25	10	6	100	100	25	10
26	10	6	100	100	26	10
27	10	6	100	100	27	10
28	10	6	100	100	28	10
29	10	6	100	100	29	10
30	10	6	100	100	30	10
31	10	6	100	100	31	10
32	10	6	100	100	32	10
33	10	6	100	100	33	10
34	10	6	100	100	34	10
35	10	6	100	100	35	10
36	10	6	100	100	36	10
37	10	6	100	100	37	10
38	10	6	100	100	38	10
39	10	6	100	100	39	10
40	10	6	100	100	40	10
41	10	6	100	100	41	10
42	10	6	100	100	42	10
43	10	6	100	100	43	10
44	10	6	100	100	44	10
45	10	6	100	100	45	10
46	10	6	100	100	46	10
47	10	6	100	100	47	10
48	10	6	100	100	48	10
49	10	6	100	100	49	10
50	10	6	100	100	50	10
51	10	6	100	100	51	10
52	10	6	100	100	52	10
53	10	6	100	100	53	10
54	10	6	100	100	54	10
55	10	6	100	100	55	10
56	10	6	100	100	56	10
57	10	6	100	100	57	10
58	10	6	100	100	58	10
59	10	6	100	100	59	10
60	10	6	100	100	60	10
61	10	6	100	100	61	10
62	10	6	100	100	62	10
63	10	6	100	100	63	10
64	10	6	100	100	64	10
65	10	6	100	100	65	10
66	10	6	100	100	66	10
67	10	6	100	100	67	10
68	10	6	100	100	68	10
69	10	6	100	100	69	10
70	10	6	100	100	70	10
71	10	6	100	100	71	10
72	10	6	100	100	72	10
73	10	6	100	100	73	10
74	10	6	100	100	74	10
75	10	6	100	100	75	10
76	10	6	100	100	76	10
77	10	6	100	100	77	10
78	10	6	100	100	78	10
79	10	6	100	100	79	10
80	10	6	100	100	80	10
81	10	6	100	100	81	10
82	10	6	100	100	82	10
83	10	6	100	100	83	10
84	10	6	100	100	84	10
85	10	6	100	100	85	10
86	10	6	100	100	86	10
87	10	6	100	100	87	10
88	10	6	100	100	88	10
89	10	6	100	100	89	10
90	10	6	100	100	90	10
91	10	6	100	100	91	10
92	10	6	100	100	92	10
93	10	6	100	100	93	10
94	10	6	100	100	94	10
95	10	6	100	100	95	10
96	10	6	100	100	96	10
97	10	6	100	100	97	10
98	10	6	100	100	98	10
99	10	6	100	100	99	10
100	10	6	100	100	100	10

## 39-INCH WHEEL

Brand	Equivalent diameter in inches	Gage range in inches	Hinge Point	
			Front	Rear
0	7	1 1/2	1 1/2	1 1/2
1	8	1 1/2	1 1/2	1 1/2
2	9	1 1/2	1 1/2	1 1/2
3	10	1 1/2	1 1/2	1 1/2
4	11	1 1/2	1 1/2	1 1/2
5	12	1 1/2	1 1/2	1 1/2
6	13	1 1/2	1 1/2	1 1/2
7	14	1 1/2	1 1/2	1 1/2
8	15	1 1/2	1 1/2	1 1/2
9	16	1 1/2	1 1/2	1 1/2
10	17	1 1/2	1 1/2	1 1/2
11	18	1 1/2	1 1/2	1 1/2
12	19	1 1/2	1 1/2	1 1/2
13	20	1 1/2	1 1/2	1 1/2
14	21	1 1/2	1 1/2	1 1/2
15	22	1 1/2	1 1/2	1 1/2
16	23	1 1/2	1 1/2	1 1/2
17	24	1 1/2	1 1/2	1 1/2
18	25	1 1/2	1 1/2	1 1/2
19	26	1 1/2	1 1/2	1 1/2
20	27	1 1/2	1 1/2	1 1/2
21	28	1 1/2	1 1/2	1 1/2
22	29	1 1/2	1 1/2	1 1/2
23	30	1 1/2	1 1/2	1 1/2
24	31	1 1/2	1 1/2	1 1/2
25	32	1 1/2	1 1/2	1 1/2
26	33	1 1/2	1 1/2	1 1/2
27	34	1 1/2	1 1/2	1 1/2
28	35	1 1/2	1 1/2	1 1/2
29	36	1 1/2	1 1/2	1 1/2
30	37	1 1/2	1 1/2	1 1/2
31	38	1 1/2	1 1/2	1 1/2
32	39	1 1/2	1 1/2	1 1/2
33	40	1 1/2	1 1/2	1 1/2

## 45-INCH WHEEL

Ring	Revolutions per Second	Discharge Rate in per Minute		Horse Power
		1	2	
4	1.1	1000	2000	3.5
5	1.3	1200	2400	4.2
6	1.5	1500	3000	5.3
7	1.7	1800	3600	6.9
8	1.9	2100	4200	8.7
9	2.1	2400	4800	10.5
10	2.3	2700	5400	12.4
11	2.5	3000	6000	14.4
12	2.7	3300	6600	16.4
13	2.9	3600	7200	18.4
14	3.1	3900	7800	20.4
15	3.3	4200	8400	22.4
16	3.5	4500	9000	24.4
17	3.7	4800	9600	26.4
18	3.9	5100	10200	28.4
19	4.1	5400	10800	30.4
20	4.3	5700	11400	32.4
21	4.5	6000	12000	34.4
22	4.7	6300	12600	36.4
23	4.9	6600	13200	38.4
24	5.1	6900	13800	40.4
25	5.3	7200	14400	42.4
26	5.5	7500	15000	44.4
27	5.7	7800	15600	46.4
28	5.9	8100	16200	48.4
29	6.1	8400	16800	50.4
30	6.3	8700	17400	52.4
31	6.5	9000	18000	54.4
32	6.7	9300	18600	56.4
33	6.9	9600	19200	58.4
34	7.1	9900	19800	60.4
35	7.3	10200	20400	62.4
36	7.5	10500	21000	64.4
37	7.7	10800	21600	66.4
38	7.9	11100	22200	68.4
39	8.1	11400	22800	70.4
40	8.3	11700	23400	72.4
41	8.5	12000	24000	74.4

## 48 INCH WHEEL

	Entnahmefahrer per Minute	Strecken- Dichte fahr per Minute	Max. Pk.
5	1	1	4 1/2
6	1	1	4
7	1	1	4
8	1	1	4
9	1	1	4
10	1	1	4
11	1	1	4
12	1	1	4
13	1	1	4
14	1	1	4
15	1	1	4
16	1	1	4
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405	1	1	4
406	1	1	4
407	1	1	4
408	1	1	

## 51 INCH WHEEL

Head.	Revolutions per Minute.	Discharge Cubic feet per Minute.	Horse Power
5	56	6345	49 3
6	44	7 23	65 1
7	39	7715	82 2
8	30	8323	103
9	25	8252	123 4
10	22	6247	80 2
11	20	6215	71
12	18	6110	61 1
13	17	6039	57
14	16	5952	53 7
15	14	5117	287 1
16	13	5106	281
17	12	5064	21 1
18	11	5117	13 2
19	10	4625	3 1
20	9	4591	1 1
21	8	4494	1 1
22	7	4426	1 1
23	6	4366	1 1
24	5	4306	1 1
25	4	4246	1 1
26	3	4186	1 1
27	2	4126	1 1
28	1	4066	1 1
29	0	4006	1 1
30	0	3946	1 1
31	0	3886	1 1
32	0	3826	1 1
33	0	3766	1 1
34	0	3706	1 1
35	0	3646	1 1
36	0	3586	1 1
37	0	3526	1 1
38	0	3466	1 1
39	0	3406	1 1
40	0	3346	1 1
41	0	3286	1 1
42	0	3226	1 1
43	0	3166	1 1
44	0	3106	1 1
45	0	3046	1 1
46	0	2986	1 1
47	0	2926	1 1
48	0	2866	1 1
49	0	2806	1 1
50	0	2746	1 1
51	0	2686	1 1
52	0	2626	1 1
53	0	2566	1 1
54	0	2506	1 1
55	0	2446	1 1
56	0	2386	1 1
57	0	2326	1 1

## 54 INCH WHEEL

Radius Inches	Result Inches	D Inches	Rate Per Minute	Horse Power
4	5	6	100	54.2
5	4	5	125	67.5
6	3	4	150	81.0
7	2	3	175	94.5
8	1.5	2.5	200	112.5
9	1	2	225	131.25
10	0.5	1.5	250	150.0
12	0.25	1	300	187.5
15	0.17	0.5	375	234.375
18	0.13	0.4	450	270.0
20	0.11	0.35	500	312.5
25	0.08	0.25	600	375.0
30	0.06	0.2	750	468.75
35	0.05	0.17	900	543.75
40	0.04	0.14	1000	625.0
45	0.035	0.12	1200	750.0
50	0.03	0.1	1500	937.5
55	0.028	0.09	1800	1125.0
60	0.026	0.08	2000	1312.5
65	0.024	0.07	2200	1500.0
70	0.022	0.06	2500	1875.0
75	0.02	0.05	3000	2343.75
80	0.018	0.045	3500	2700.0
85	0.017	0.04	4000	3125.0
90	0.016	0.035	4500	3750.0
95	0.015	0.03	5000	4687.5
100	0.014	0.028	6000	5437.5

## 57-INCH WHEEL

Horse.	Revolutions per Minute	Discharge.		Horse Power
		Cubic feet per Minute	Secs.	
5	412	100.36	65.3	
6	47	140.22	55.7	
7	4.2	210.31	43.8	
8	3.5	310.37	32.2	
9	2.7	430.61	25.5	
10	2.0	560.74	20.8	
11	1.7	690.87	18.8	
12	1.5	820.97	17.3	
13	1.3	941.05	16.2	
14	1.2	1051.12	15.4	
15	1.1	1151.19	14.9	
16	1.0	1246.26	14.5	
17	0.9	1331.33	14.2	
18	0.8	1411.40	13.9	
19	0.7	1486.47	13.6	
20	0.6	1556.54	13.3	
21	0.5	1621.60	13.0	
22	0.4	1681.67	12.8	
23	0.3	1736.73	12.6	
24	0.2	1786.78	12.4	
25	0.1	1831.83	12.2	
26	0.0	1871.87	12.0	
27	1.5	1993.94	11.7	
28	1.2	2093.97	11.4	
29	1.0	2279.97	11.1	
30	0.8	2451.94	10.8	
31	0.6	2618.91	10.5	
32	0.5	2779.87	10.2	
33	0.4	2934.83	9.9	
34	0.3	2984.77	9.6	
35	0.2	3030.71	9.3	
36	0.1	3071.67	9.0	
37	0.0	3106.63	8.7	
38	0.0	3136.59	8.4	
39	0.0	3160.54	8.1	
40	0.0	3180.49	7.8	
41	0.0	3200.43	7.5	
42	0.0	3215.37	7.2	
43	0.0	3230.31	6.9	
44	0.0	3245.24	6.6	
45	0.0	3260.17	6.3	
46	0.0	3275.09	6.0	
47	0.0	3290.01	5.7	
48	0.0	3305.92	5.4	
49	0.0	3320.83	5.1	
50	0.0	3335.73	4.8	
51	0.0	3350.62	4.5	
52	0.0	3365.51	4.2	
53	0.0	3380.40	3.9	
54	0.0	3395.29	3.6	
55	0.0	3410.17	3.3	
56	0.0	3425.05	3.0	
57	0.0	3440.92	2.7	
58	0.0	3455.79	2.4	
59	0.0	3470.65	2.1	
60	0.0	3485.51	1.8	
61	0.0	3500.36	1.5	
62	0.0	3515.21	1.2	
63	0.0	3530.05	0.9	
64	0.0	3544.89	0.6	
65	0.0	3559.72	0.3	

## 60-INCH WHEEL

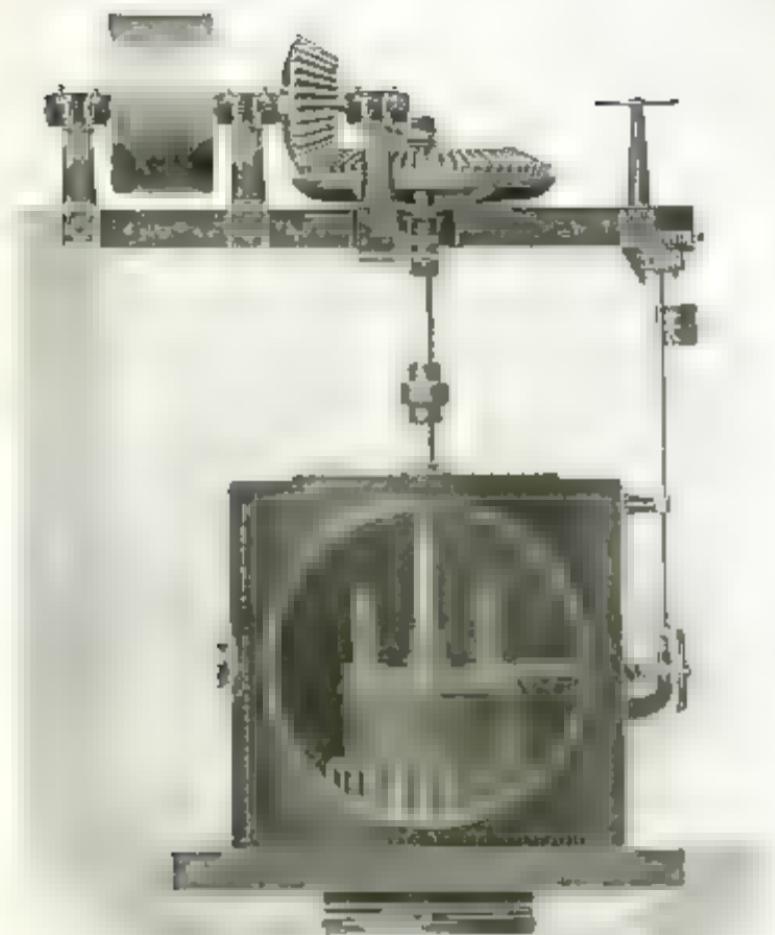
Height	Revolutions per Minute	Distance Covered per Revolution	Horse Power
4	42	10.2	100
5	45	10.4	100
6	48	10.6	100
7	51	10.8	100
8	54	11.0	100
9	57	11.2	100
10	60	11.4	100
11	63	11.6	100
12	66	11.8	100
13	69	12.0	100
14	72	12.2	100
15	75	12.4	100
16	78	12.6	100
17	81	12.8	100
18	84	13.0	100
19	87	13.2	100
20	90	13.4	100
21	93	13.6	100
22	96	13.8	100
23	99	14.0	100
24	102	14.2	100
25	105	14.4	100
26	108	14.6	100
27	111	14.8	100
28	114	15.0	100
29	117	15.2	100
30	120	15.4	100
31	123	15.6	100
32	126	15.8	100
33	129	16.0	100
34	132	16.2	100
35	135	16.4	100
36	138	16.6	100
37	141	16.8	100
38	144	17.0	100
39	147	17.2	100
40	150	17.4	100
41	153	17.6	100
42	156	17.8	100
43	159	18.0	100
44	162	18.2	100
45	165	18.4	100
46	168	18.6	100
47	171	18.8	100
48	174	19.0	100
49	177	19.2	100
50	180	19.4	100
51	183	19.6	100
52	186	19.8	100
53	189	20.0	100
54	192	20.2	100
55	195	20.4	100
56	198	20.6	100
57	201	20.8	100
58	204	21.0	100
59	207	21.2	100
60	210	21.4	100
61	213	21.6	100
62	216	21.8	100
63	219	22.0	100
64	222	22.2	100
65	225	22.4	100
66	228	22.6	100
67	231	22.8	100
68	234	23.0	100
69	237	23.2	100
70	240	23.4	100
71	243	23.6	100
72	246	23.8	100
73	249	24.0	100
74	252	24.2	100
75	255	24.4	100
76	258	24.6	100
77	261	24.8	100
78	264	25.0	100
79	267	25.2	100
80	270	25.4	100
81	273	25.6	100
82	276	25.8	100
83	279	26.0	100
84	282	26.2	100
85	285	26.4	100
86	288	26.6	100
87	291	26.8	100
88	294	27.0	100
89	297	27.2	100
90	300	27.4	100
91	303	27.6	100
92	306	27.8	100
93	309	28.0	100
94	312	28.2	100
95	315	28.4	100
96	318	28.6	100
97	321	28.8	100
98	324	29.0	100
99	327	29.2	100
100	330	29.4	100

## 66-INCH WHEEL

Read.	Revolutions per Minute.	Discharge Capacity per Minute.	Horse Power
4	35	11.75	5
5	42	13.54	4.4
6	46	14.14	3.6
7	49	14.41	3.4
8	51	14.57	3.3
9	53	14.65	3.3
10	55	14.72	3.2
11	57	14.78	3.2
12	59	14.83	3.2
13	61	14.87	3.2
14	63	14.91	3.2
15	65	14.94	3.2
16	67	14.97	3.2
17	69	15.00	3.2
18	71	15.02	3.2
19	73	15.04	3.2
20	75	15.06	3.2
21	76	15.07	3.2
22	78	15.08	3.2
23	80	15.09	3.2
24	82	15.10	3.2
25	84	15.11	3.2
26	86	15.12	3.2
27	87	15.13	3.2
28	89	15.14	3.2
29	91	15.15	3.2
30	92	15.16	3.2
31	93	15.17	3.2
32	94	15.18	3.2
33	95	15.19	3.2
34	96	15.20	3.2
35	98	15.21	3.2
36	100	15.22	3.2
37	102	15.23	3.2
38	103	15.24	3.2
39	105	15.25	3.2
40	107	15.26	3.2
41	109	15.27	3.2

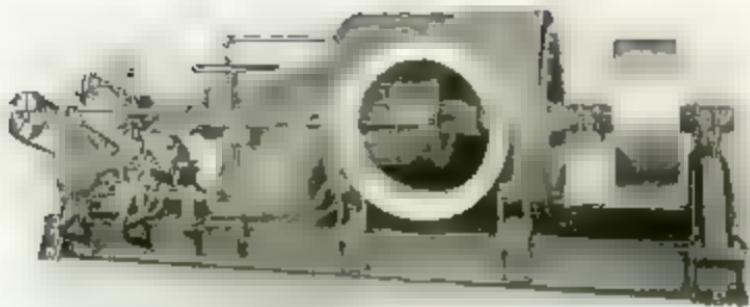
## 72-INCH WHEEL

Item	Revolution per Min. in	Discharge Cubic feet per Min. in	Horse Power
4	7	1.2 06	54.4
5	4.5	16.5 5	13.5 5
6	4.2	121.9	64.2
7	4.0	101.50	56.3
8	3.5	2.974	25.2 9
9	3.0	7.04	31
10	2.5	2.412	15.4
11	6	7.05 9	17.9
12	5.5	5.01 2	16.6
13	6	3.01 9	10.5
14	7	3.52	5.86
15	7.5	2.51 8	6.46 6
16	4	30.6 1	7.66 0
17	3.5	2.40 2	7.54 7
18	3.5	1.1 25	5.51 2
19	3	1.7 7	4.12 3
20	3.5	1.1 11	4.04 2
21	3.5	1.1 11	3.86 0
22	3.5	1.1 11	3.53 9
23	3.5	1.1 11	3.23 2
24	3.5	1.1 11	3.01 9
25	4.5	17.1 7	4.34 5
26	3	17.1 3	4.25 5
27	3.5	15.1 8	4.03 4
28	3.5	16.1	4.03 3
29	3.5	16.1 7	4.74 3
30	10.2	40.5 4	6.2 5
31	10	41.7 9	6.29 3
32	10.5	41.8 3	7.1 2
33	12	42.5 4	7.31 2
34	10.5	41.8 3	7.2 2
35	7	4.50	22.8 4
36	12	44.1 0	2.5 5 5
37	15	42.5 4	25.7 6
38	7.5	43.2 9	26.20 0
39	16	44.7 2	27.76 7
40	15.5	45.0 6	28.24 8



Engraving No. 404

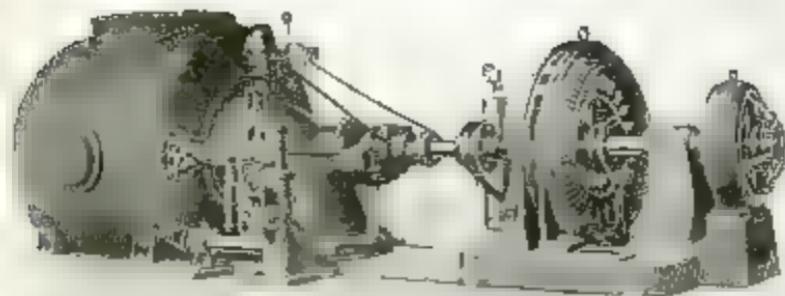




Engraving No. 406.



Engraving No. 407



Engraving No. 408.

Steam turbine shaft turbine in plate steel case with simple gear connection at the top. The main turbine, generator and pump shafts are all connected by a vertical shaft.



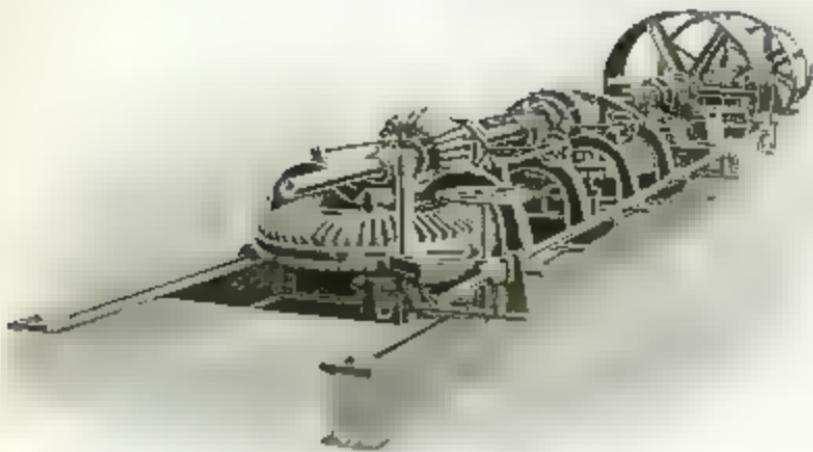
Engraving No. 409

Steam turbine in plate steel case with double discharge, each case discharge for water or air. The flow air draft tube having a shaft tube with coupling for direct con-

Engineering No. 410.

Patent applied for under Act of Congress, 1870, to  
John C. Dugay, of Boston, Mass., for  
Improvement in  
Furnaces.





Engraving No. 411

Engraving No. 411  
A detailed cross-sectional diagram of a mechanical device, likely a pump or compressor, showing internal components like a piston, connecting rod, and valves. A small cylindrical component is shown below the main assembly.

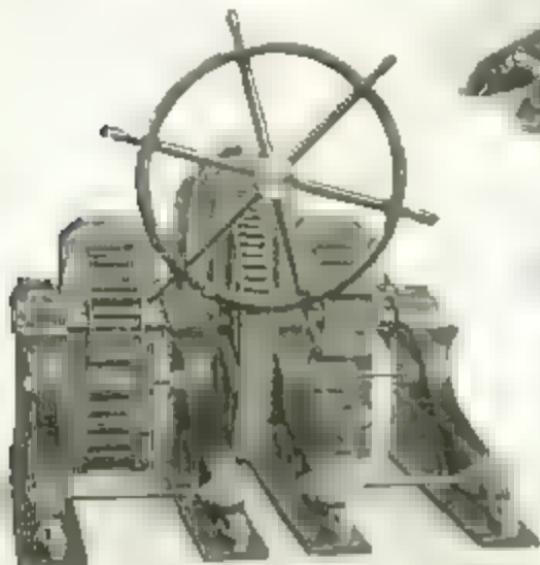


Engraving No. 412

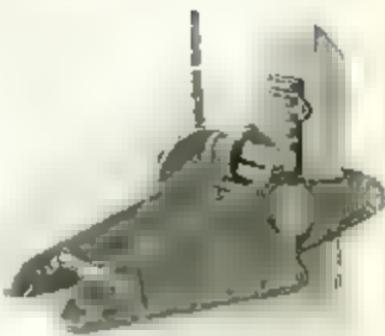
Engraving No. 412  
A detailed cross-sectional diagram of a mechanical device, likely a pump or compressor, showing internal components like a piston, connecting rod, and valves. A small cylindrical component is shown below the main assembly.

## Head Gate Hoists

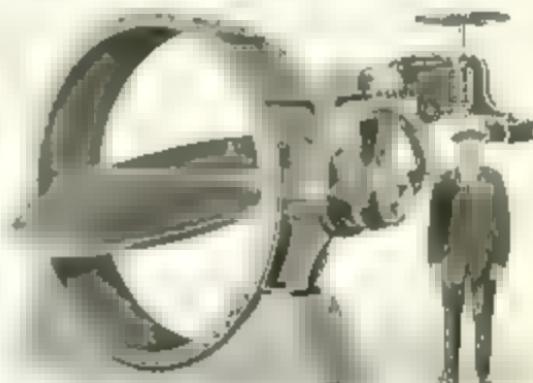
We have published special  
Tech. No. 189 devoted ex-  
clusively to Head Gate Hoists and  
valves, copy of which will be  
mailed on application.



Engraving No. 414



Engraving No. 413



Engraving No. 415

Large water gate valve  
w/ worm geared ratio  
limiting mechanism

## Measurement of Large Streams

where the velocity is quite uniform, the velocity in feet per second in the center of the stream is given by the formula

in which  $h$  is 20 per cent for losses by friction, etc.

## Measurement of Water Through Openings Under Pressure

Table giving the rate of flow through an orifice in feet per second

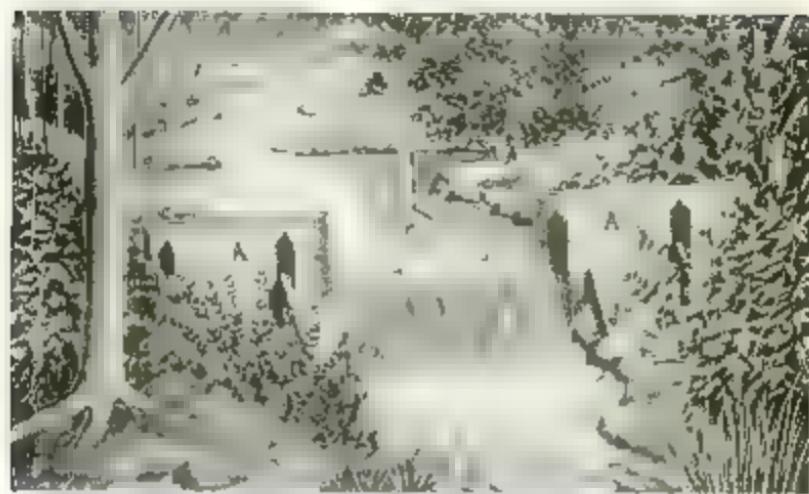
Ratio of head	Head	Cubic feet	Head	1	2	3	4	5	6	7	8	9	10
1.1	1	2.4	2.1	1	2	3	4	5	6	7	8	9	10
1.2	2	2.7	2.3	2	3	4	5	6	7	8	9	10	11
1.3	3	2.9	2.4	3	4	5	6	7	8	9	10	11	12
1.4	4	3.0	2.5	4	5	6	7	8	9	10	11	12	13
1.5	5	3.0	2.6	5	6	7	8	9	10	11	12	13	14
1.6	6	3.0	2.7	6	7	8	9	10	11	12	13	14	15
1.7	7	3.0	2.8	7	8	9	10	11	12	13	14	15	16
1.8	8	3.0	2.9	8	9	10	11	12	13	14	15	16	17
1.9	9	3.0	3.0	9	10	11	12	13	14	15	16	17	18
2.0	10	3.0	3.0	10	11	12	13	14	15	16	17	18	19
2.1	11	3.0	3.0	11	12	13	14	15	16	17	18	19	20
2.2	12	3.0	3.0	12	13	14	15	16	17	18	19	20	21

### EXAMPLE SHOWING APPLICATION OF ABOVE TABLE

Suppose the orifice has a head of 15 inches and the water is flowing at the rate of 10 cubic feet per second. Then the number of square feet of the orifice is

divided by 10,000, giving 1.5. Then the number of feet of the orifice is the square root of 1.5, or 1.225.

## Rules for Measuring Water by Weirs



Engraving No. 416.

When a stream is to be measured, the first thing to do is to measure the head and width of water in the stream. The following rule is given for determining the amount of water in a small stream:

Length of Weir  $\times$  Head of Water  $\times$  Width of Stream  $\times$  0.0256 = Cubic feet per second.

For example, if the head of water is 10 inches, the width of stream is 10 feet, and the length of the weir is 100 feet, then the amount of water is 100  $\times$  10  $\times$  10  $\times$  0.0256 = 256 cubic feet per second.

For a stream 100 feet wide, the head of water is 10 inches, and the length of the weir is 100 feet, then the amount of water is 100  $\times$  10  $\times$  100  $\times$  0.0256 = 25,600 cubic feet per second.

For a stream 100 feet wide, the head of water is 10 inches, and the length of the weir is 10 feet, then the amount of water is 100  $\times$  10  $\times$  10  $\times$  0.0256 = 256 cubic feet per second.

For a stream 100 feet wide, the head of water is 10 inches, and the length of the weir is 1000 feet, then the amount of water is 1000  $\times$  10  $\times$  100  $\times$  0.0256 = 25,600,000 cubic feet per second.

Table Showing the Quantity of Water Passing Over Weirs in Cubic Feet per Minute

Cathode		Anode		Current		Voltage		Polarization		Electrode	
Material	Thickness	Material	Thickness	Amperes	Volts	Volts	Volts	Amperes	Volts	Material	Thickness
1	4.45	+	50.00	20	170.18	124	214.42				
1	5.78	+	52.00	20	142.42	12	221.76				
1	6.18	+	54.00	20	122.2	14	222.40				
1	7.80	+	56.00	20	128.4	13	233.52				
1	8.90	+	58.00	20	130.93	13.5	240.84				
1	10.00	+	60.00	20	133.65	12.5	247.22				
1	11.2	+	62.00	20	134.43	1	254.13				
1	12.5	+	64.00	20	137.18	4	261.83				
1	13.8	+	66.00	20	141.90	4.5	267.75				
1	15.0	+	68.00	20	144.80	14	274.70				
1	16.3	+	70.00	20	147.64	15	281.52				
1	17.5	+	72.00	20	150.47	14	288.32				
1	18.8	+	74.00	20	151.3	15	295.13				
1	20.0	+	76.00	20	152.7	1	301.1				
1	22.1	+	78.00	20	153.14	14	310.36				
1	23.3	+	80.00	20	154.57	14	317.5				
1	24.5	+	82.00	20	154.99	1	322.3				
1	25.7	+	84.00	20	156.54	1	327.7				
1	26.9	+	86.00	20	157.93	1	334.1				
1	28.1	+	88.00	20	159.34	1	340.36				
1	29.3	+	90.00	20	160.7	14	347.45				
1	30.5	+	92.00	20	161.99	1	352.3				
1	31.7	+	94.00	20	162.54	1	357.7				
1	32.9	+	96.00	20	163.93	1	362.5				
1	34.1	+	98.00	20	165.24	18	370.34				
1	35.3	+	100.00	20	166.03	18.5	378.2				
1	36.5	+	102.00	20	169.13	18.5	385.7				
1	37.7	+	104.00	20	171.20	18	393.0				
1	38.9	+	106.00	20	173.42	18	401.3				
1	40.1	+	108.00	20	174.67	19	408.48				
1	41.3	+	110.00	20	176.9	18	417.48				
1	42.5	+	112.00	20	178.14	18	425.48				

For explanation of above table and construction of Webs see previous section.

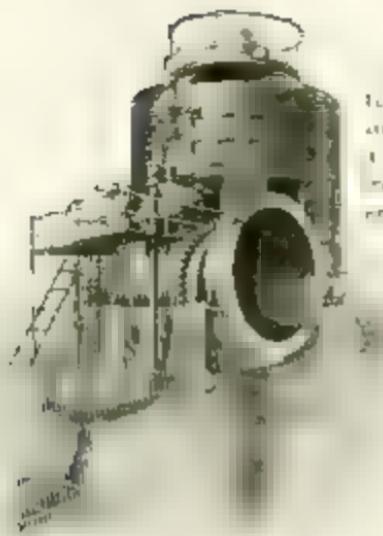
# Velocity of Water

Table giving velocity of water in feet per second, and the cubic feet of water per minute, to develop one horse-power at 80 per cent efficiency, under head from 1 to 207 feet.

Head	Velocity in feet per second	Velocity in feet per minute	Cubic feet per minute	Velocity in feet per second	Velocity in feet per minute	Cubic feet per minute
1	3.7	222	13.3	3.4	200	12.0
2	5.4	322	20.0	5.2	300	18.7
3	7.3	422	26.7	7.0	380	23.3
4	9.3	522	33.3	8.9	440	28.0
5	11.4	622	40.0	10.9	500	32.7
6	13.6	722	46.7	13.0	560	37.4
7	15.9	822	53.3	15.2	620	42.1
8	18.3	922	60.0	17.5	680	46.8
9	20.8	1022	66.7	19.9	740	51.5
10	23.3	1122	73.3	22.4	800	56.2
11	25.9	1222	80.0	25.0	860	60.9
12	28.6	1322	86.7	27.7	920	65.6
13	31.3	1422	93.3	30.4	980	70.3
14	34.1	1522	100.0	33.2	1040	75.0
15	36.9	1622	106.7	36.0	1100	79.7
16	39.8	1722	113.3	38.9	1160	84.4
17	42.7	1822	120.0	41.8	1220	89.1
18	45.7	1922	126.7	44.7	1280	93.8
19	48.7	2022	133.3	47.6	1340	98.5
20	51.8	2122	140.0	50.5	1400	103.2
21	55.0	2222	146.7	53.4	1460	107.9
22	58.2	2322	153.3	56.3	1520	112.6
23	61.5	2422	160.0	59.2	1580	117.3
24	64.8	2522	166.7	62.1	1640	122.0
25	68.2	2622	173.3	65.0	1700	126.7
26	71.6	2722	180.0	67.9	1760	131.4
27	75.0	2822	186.7	70.8	1820	136.1
28	78.5	2922	193.3	73.7	1880	140.8
29	82.0	3022	200.0	76.6	1940	145.5
30	85.5	3122	206.7	79.5	2000	150.2
31	89.1	3222	213.3	82.4	2060	154.9
32	92.7	3322	220.0	85.3	2120	159.6
33	96.3	3422	226.7	88.2	2180	164.3
34	100.0	3522	233.3	91.1	2240	169.0
35	103.7	3622	240.0	94.0	2300	173.7
36	107.4	3722	246.7	96.9	2360	178.4
37	111.2	3822	253.3	100.0	2420	183.1
38	115.0	3922	260.0	102.9	2480	187.8
39	118.8	4022	266.7	105.8	2540	192.5
40	122.6	4122	273.3	108.7	2600	197.2
41	126.4	4222	280.0	111.6	2660	201.9
42	130.2	4322	286.7	114.5	2720	206.6
43	134.0	4422	293.3	117.4	2780	211.3
44	137.8	4522	300.0	120.3	2840	216.0
45	141.6	4622	306.7	123.2	2900	220.7
46	145.4	4722	313.3	126.1	2960	225.4
47	149.2	4822	320.0	129.0	3020	230.1
48	153.0	4922	326.7	131.9	3080	234.8
49	156.8	5022	333.3	134.8	3140	239.5

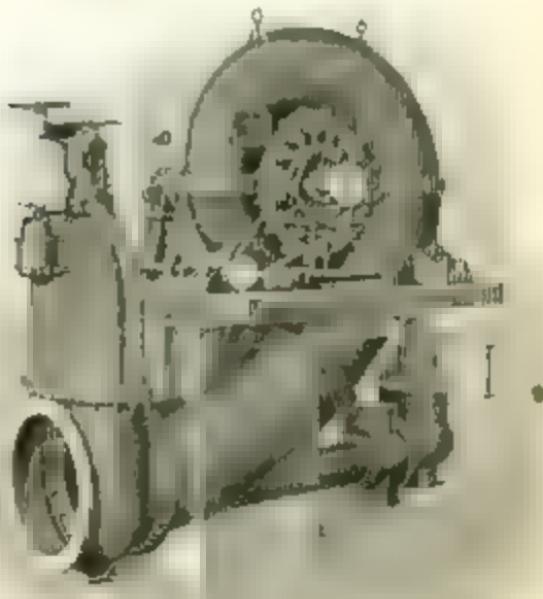
#### VELOCITY OF WATER. Continued

## "Francis" Turbines



We are enabled to design and build Francis turbines for heads up to 1000 feet, with diameters up to 10 feet. Engraving 417 illustrates a Francis turbine with a vertical shaft. Engraving 418 shows a horizontal shaft serial case.

Engraving No. 417



Engraving No. 418.



## 18-INCH WHEEL

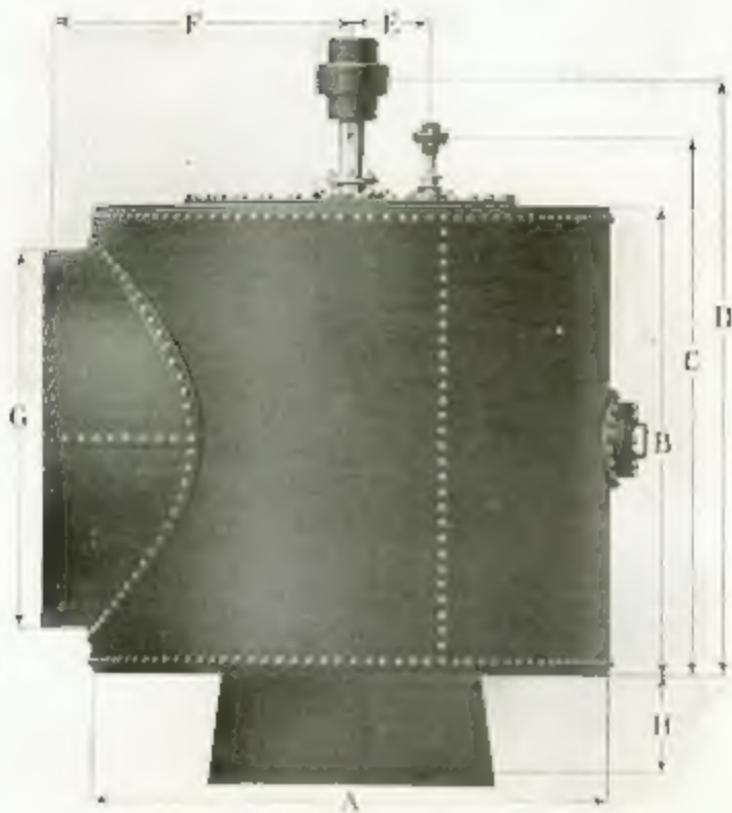
Height	Spur-to-teeth per diameter	Diam. of the pitch circle in inches	Outer Pitch
1	15	1.57	1.57
2	8	2.36	2.36
3	5.33	3.54	3.54
4	4	4.71	4.71
5	3.33	5.89	5.89
6	2.67	7.07	7.07
7	2	8.25	8.25
8	1.67	9.42	9.42
9	1.33	10.60	10.60
10	1.11	11.78	11.78
11	0.92	12.95	12.95
12	0.75	14.13	14.13
13	0.61	15.30	15.30
14	0.5	16.48	16.48
15	0.41	17.65	17.65
16	0.33	18.82	18.82
17	0.26	20.00	20.00
18	0.21	21.17	21.17
19	0.17	22.35	22.35
20	0.14	23.52	23.52

## 21-INCH WHEEL

Head	Manufacture per Minute.	Discharge, cubic feet per minute.	Horse Power.
5	137	1172	8.9
6	150	1288	11.0
7	162	1396	14.7
8	173	1482	17.9
9	184	1572	21.4
10	194	1657	25.0
11	204	1738	28.9
12	212	1815	32.9
13	223	1889	37.4
14	229	1960	41.3
15	237	2029	46.0
16	245	2090	50.7
17	253	2150	55.5
18	260	2203	60.5
19	267	2254	65.6
20	274	2313	70.8
21	281	2364	76.1
22	287	2417	81.2
23	294	2463	87.1
24	301	2507	93.1
25	308	2550	99.0
26	312	2572	103.0
27	318	2612	111.1
28	324	2672	117.3
29	330	2724	123.6
30	336	2779	130.1
31	341	2817	136.6
32	347	2861	143.3
33	352	2909	150.1
34	357	2955	157.0
35	362	3100	163.9
36	368	3144	171.6
37	373	3187	178.2
38	378	3230	185.1
39	383	3272	192.9
40	387	3314	200.3

## 42-INCH WHEEL

Head.	Revolutions per Minute.	Discharge. Cubic feet per minute.	Horse Power.
5	67	4786	36.2
6	74	5242	47.5
7	80	5662	59.9
8	85	6053	73.2
9	90	6421	87.3
10	95	6768	102.3
11	100	7098	118.0
12	104	7411	134.4
13	108	7717	151.6
14	112	8008	169.4
15	116	8289	187.9
16	120	8561	207.0
17	124	8824	226.7
18	128	9080	247.0
19	131	9329	267.8
20	134	9571	289.3
21	138	9808	311.3
22	141	10038	333.7
23	144	10264	356.7
24	147	10485	380.3
25	150	10701	404.3
26	153	10913	428.7
27	156	11121	453.7
28	159	11325	479.1
29	162	11525	505.0
30	165	11722	531.4
31	167	11916	558.2
32	170	12107	585.4
33	173	12294	613.1
34	175	12479	641.1
35	178	12661	669.6
36	180	12841	695.5
37	183	13013	727.8
38	185	13193	757.5
39	188	13365	787.6
40	190	13536	818.1



Engraving No. 405.

The price of steel flumes usually exceeds the cost of those constructed from wood, but for many locations they are more desirable on account of their durability and freedom from leakage.

Each flume has a heavy cast iron top and bottom. The top is provided with a lid of sufficient size to admit the wheel and contains packing boxes for wheel and gate shafts.

A man door is conveniently located on the side of the flume affording easy access to the water wheel. See dimensions of flumes on page 37.

# DIMENSIONS OF STEEL FLUMES IN INCHES

Lettered columns correspond with letters in Engraving No. 495

Diameter of Wheel	A	B	C	D	E	F	G	H
9	36	36		57 $\frac{1}{2}$		24	24	6 $\frac{1}{4}$
12	42	42		64 $\frac{1}{2}$		27	30	7 $\frac{3}{8}$
15	48	48		70 $\frac{1}{2}$		30	36	9 $\frac{1}{4}$
18	54	54	69 $\frac{1}{2}$	76 $\frac{1}{2}$		33	42	10 $\frac{1}{2}$
21	60	60	75 $\frac{1}{2}$	83		38	48	12 $\frac{1}{2}$
24	72	70	85 $\frac{1}{2}$	93		44	54	13 $\frac{1}{2}$
27	84	76	91 $\frac{1}{2}$	99		50	60	15 $\frac{1}{2}$
30	90	82	97 $\frac{1}{2}$	106 $\frac{1}{2}$		53	66	16 $\frac{1}{2}$
33	96	90	100 $\frac{1}{2}$	119		56	72	18 $\frac{1}{2}$
36	102	96	114 $\frac{1}{2}$	128		59	78	21 $\frac{1}{2}$
39	108	102	120 $\frac{1}{2}$	128 $\frac{1}{2}$		62	84	22 $\frac{1}{2}$
42	114	108	126 $\frac{1}{2}$	137 $\frac{1}{2}$		65	90	25 $\frac{1}{4}$
45	120	112	130 $\frac{1}{2}$	142 $\frac{1}{2}$		68	94	26 $\frac{3}{4}$
48	126	114	132 $\frac{1}{2}$	144 $\frac{1}{2}$		71	96	28 $\frac{1}{4}$
51	132	118	130 $\frac{1}{2}$	152 $\frac{1}{2}$		74	103	29 $\frac{1}{4}$
54	144	122	144	156 $\frac{1}{2}$		80	104	21 $\frac{1}{2}$
57	156	126	148	161 $\frac{1}{2}$		86	108	23 $\frac{1}{4}$
60	168	132	154	167 $\frac{1}{2}$		92	114	25
63	180	138	160	173 $\frac{1}{2}$		98	120	21
72	200	162	184	197 $\frac{1}{2}$		108	144	46 $\frac{1}{2}$

Dimensions given upon application